Optical effects of clouds on trace-gas absorption

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atmospheric absorption

oud fraction
eometric)

oud optical depth

rface albedo

oud vertical structure

Radiative cloud fra

Radiative cloud pro

nition: Fraction of measured radiation that is scattered by clo

$$f_R = f_g \frac{I_c}{I_m}$$

ere I_c and I_m are the cloudy and measured (total) radiances, respectiv
normalized by solar irradiance) and f_g is the geometrical cloud fractio

It can be shown approximately that

$$\tau_m^{abs} = \tau_c^{abs} f_R + \tau_s^{abs}(1 - f_R)$$

$$\therefore N_m = N_c f_R + N_s(1 - f_R)$$

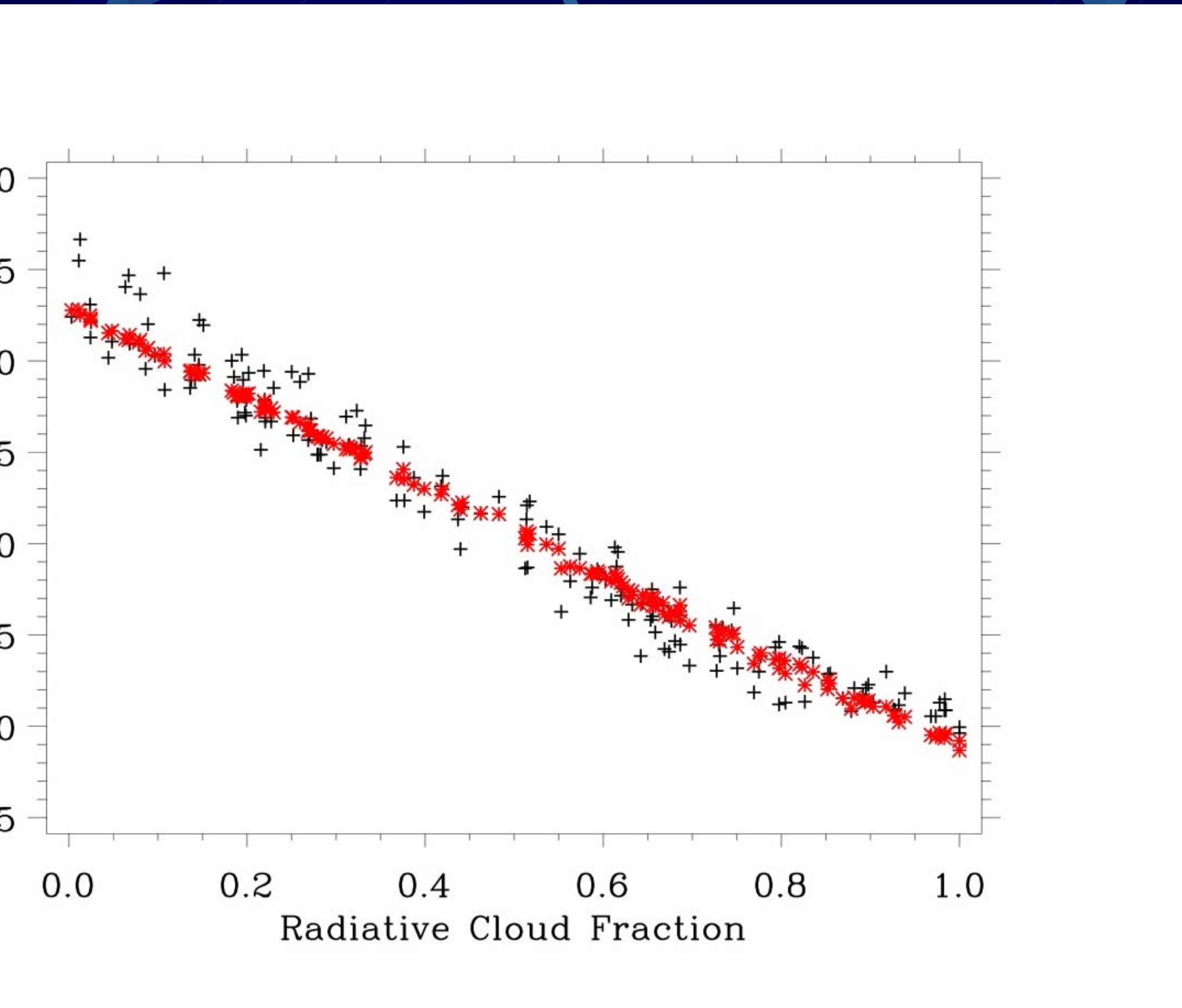
ud is brighter than the surrounding atmosphere then $f_R > f_g$.

on-absorbing atmosphere, f_R increases with λ (I_m decreases
t change).

be computed with simple cloud models

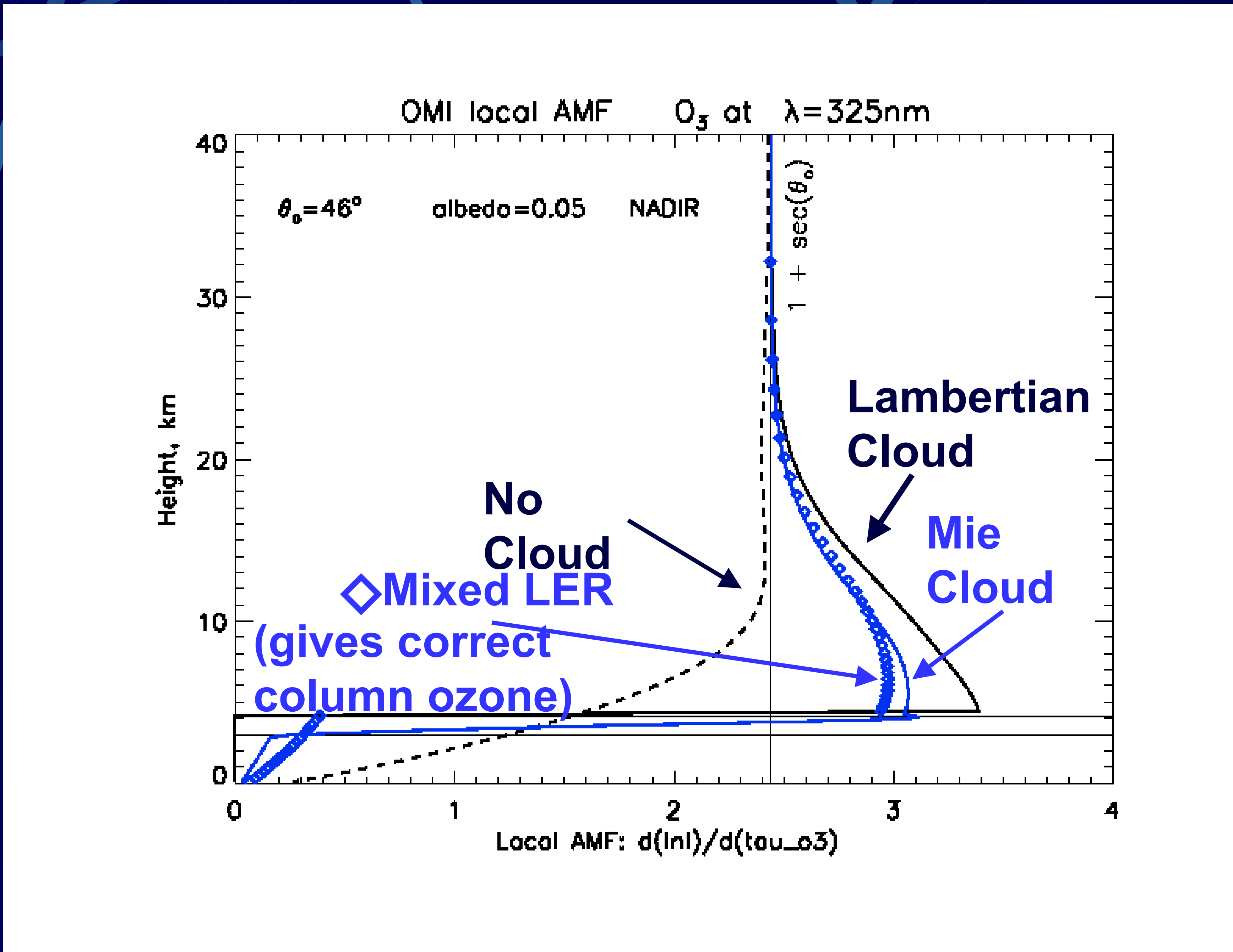
- **mbertian-equivalent reflectivity (LER):** Surfac
oud/ground) is an opaque and isotropic scattere
ectivity R
- **xed LER:** Pixel is composed of weighted clear a
udy components; In OMI algorithms, clouds are
sumed to have R=0.8; Proper weighting via f_r
counts for light scattered from beneath the clouc
- **ane-Parallel Cloud (PPC):** Use Mie scattering t
h a horizontally infinite and vertically homogene
ud with an effective optical depth (related to f_r).
- **xed PPC:** Similar to Mie Mixed LER but uses PPC r
cloud

Rayleigh scattering with simple cloud models?



- Rayleigh scatt can be describ well by simple MLER model w parameter (no significantly af by cloud vertic structure)
- Implication: Ma need subpixel imager on futu instrument

adiative cloud fraction conce work for trace-gas absorption



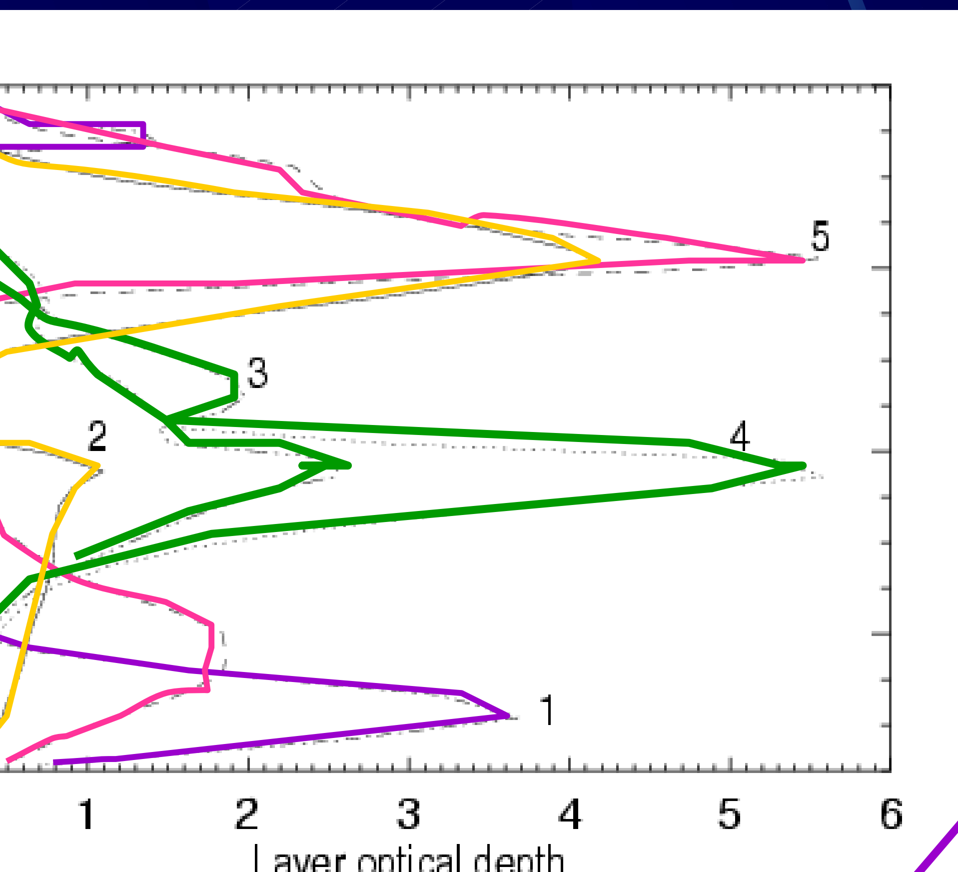
Cloudsat (A-train) helps us to answer

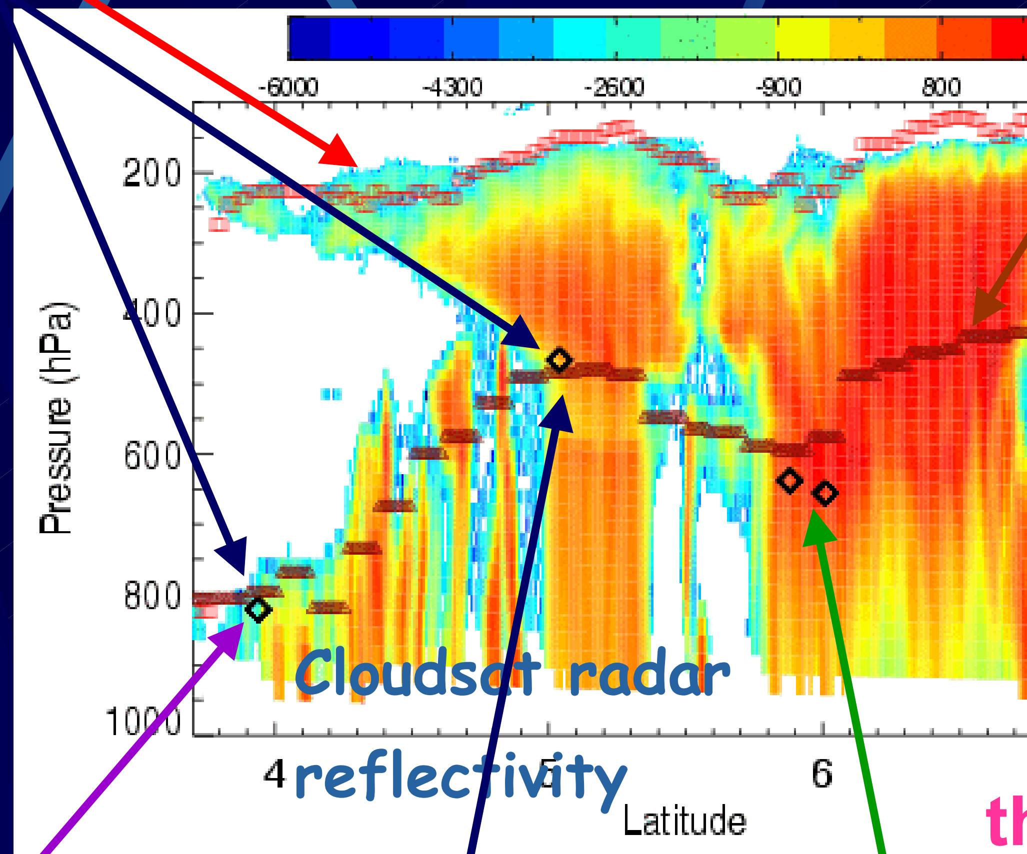
MODIS: sensitive to cloud-top (not appropriate for UV-VIS trace-gas retrievals)

OMI radiative cloud pres Raman scattering: UV/vi penetrates deeper

OMI simulated from Cloudsat

at optical depth profiles





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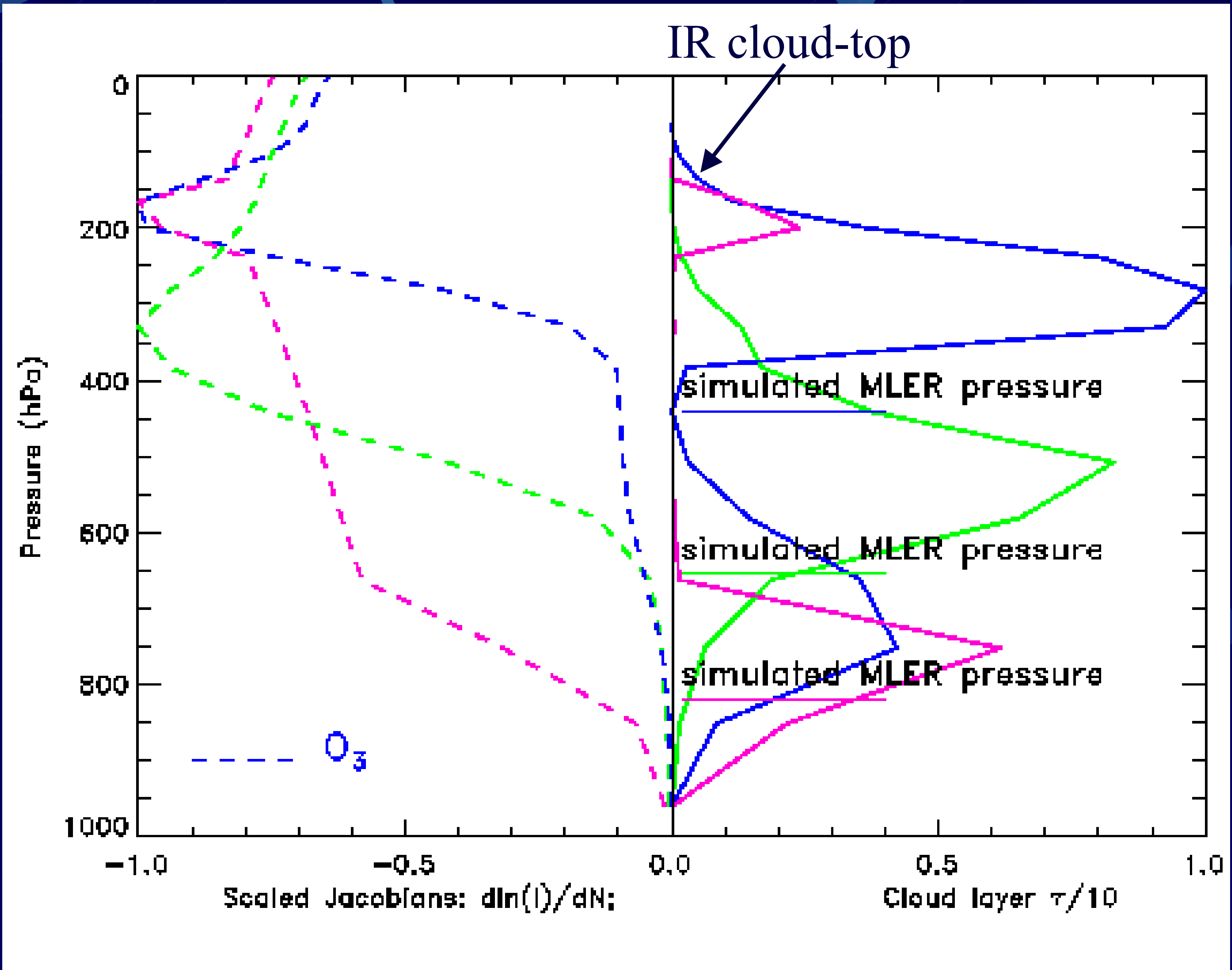
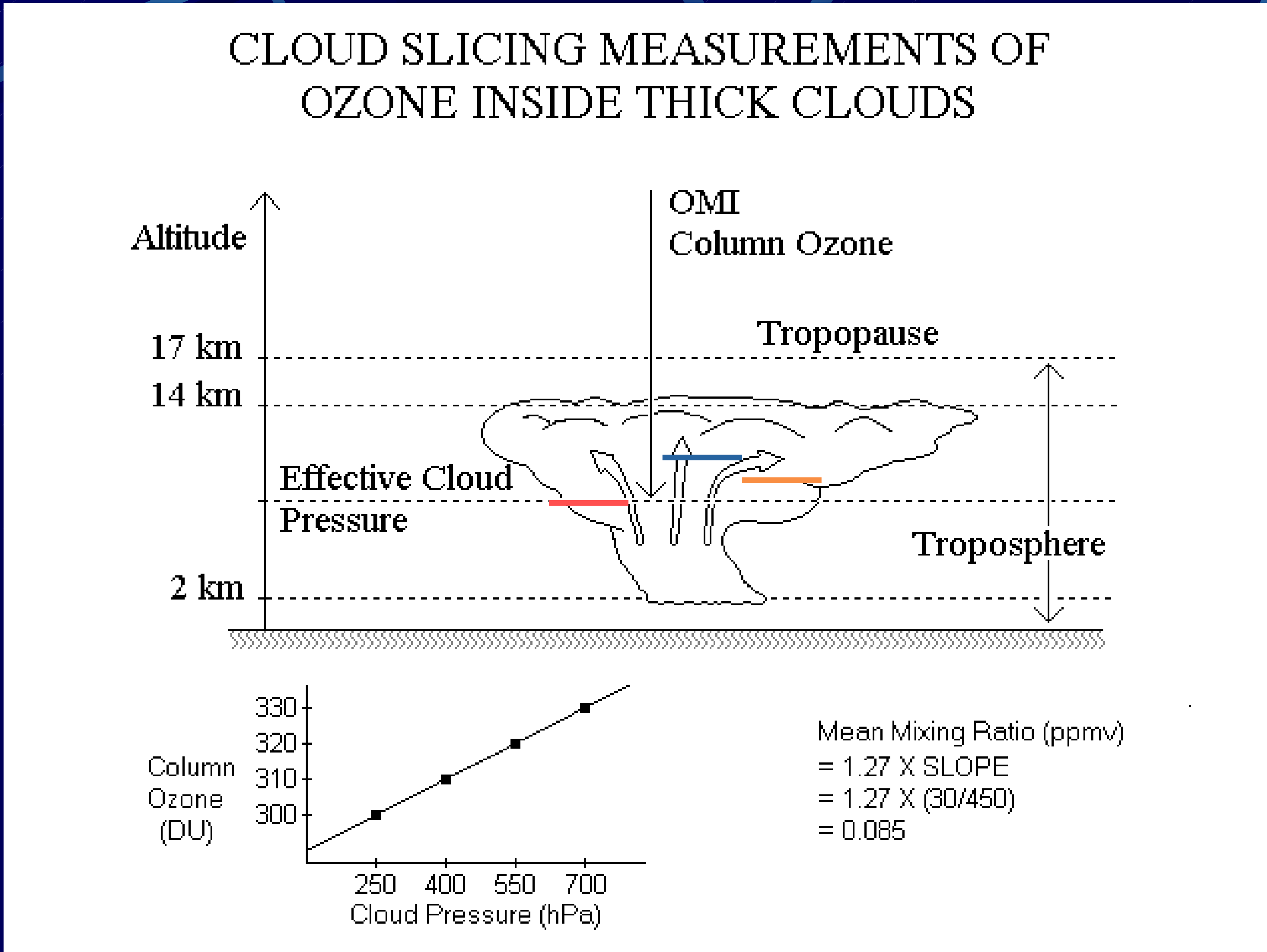
Optical depth

Optical de peaks in li

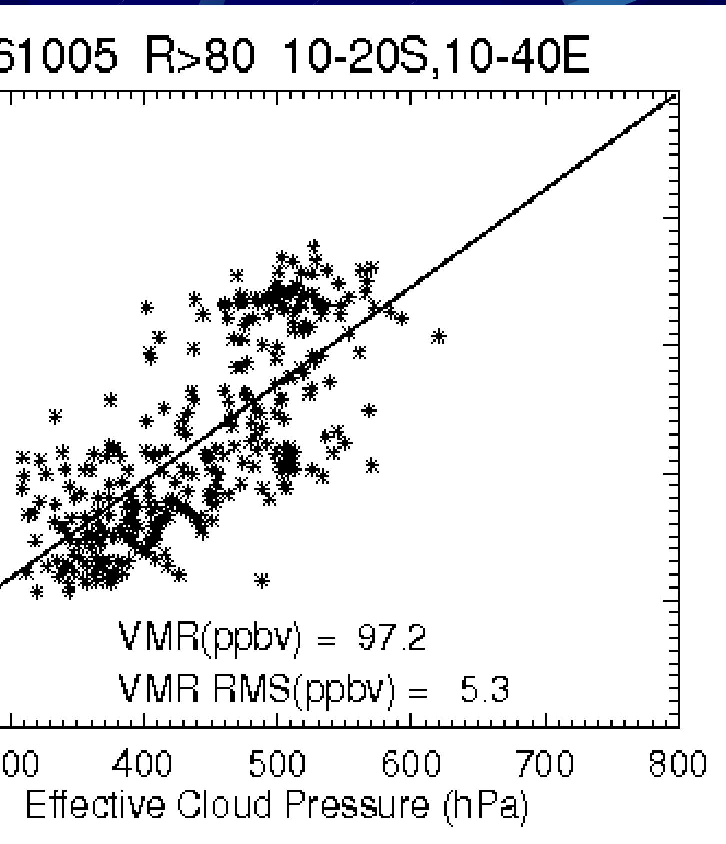
significant photon penetration inside clouds





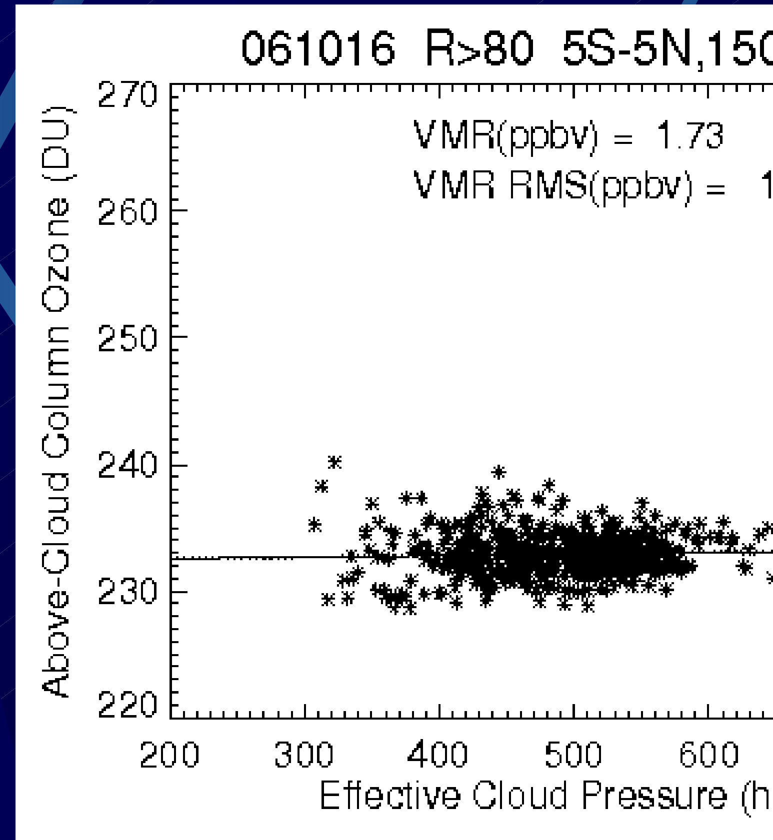
nke *et al*., in prep. (2007) – see poster

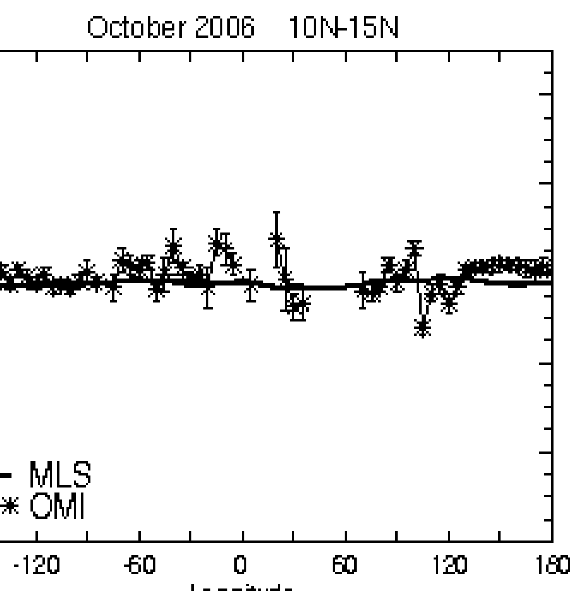
Africa

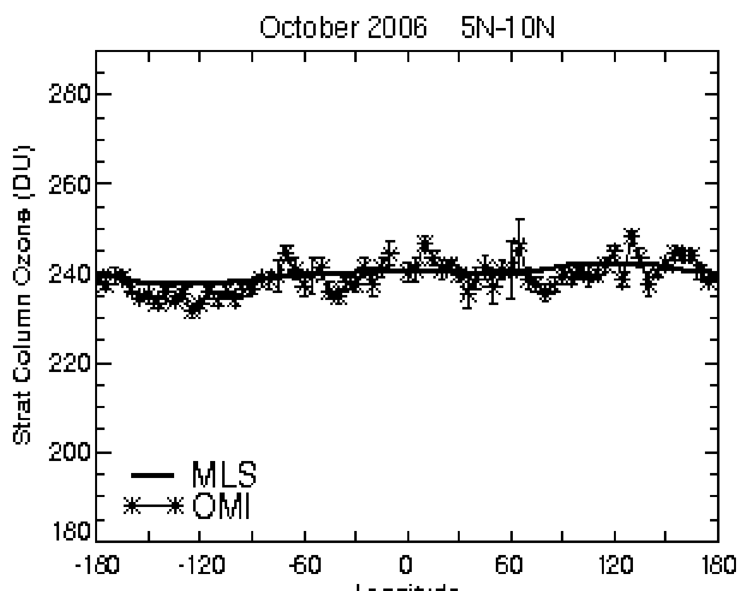


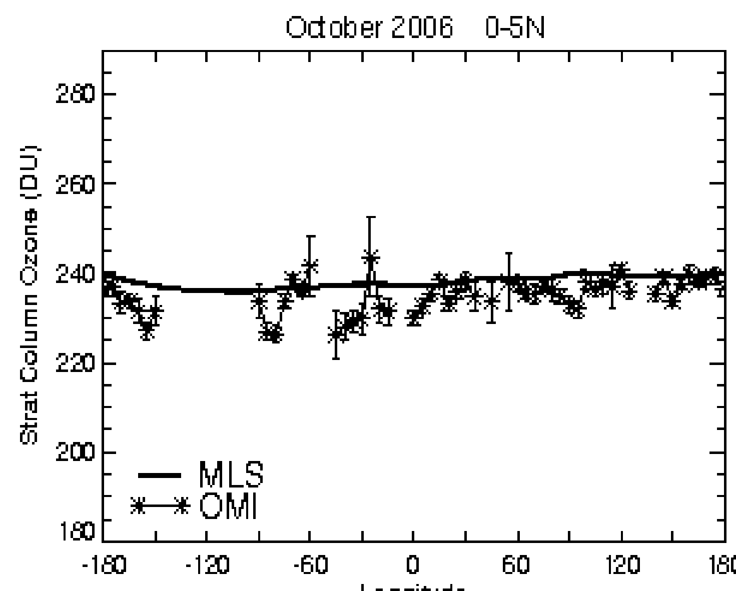
Provides indirect validation of retrieved cloud-pressures

Pacific









A-train cloud synergy

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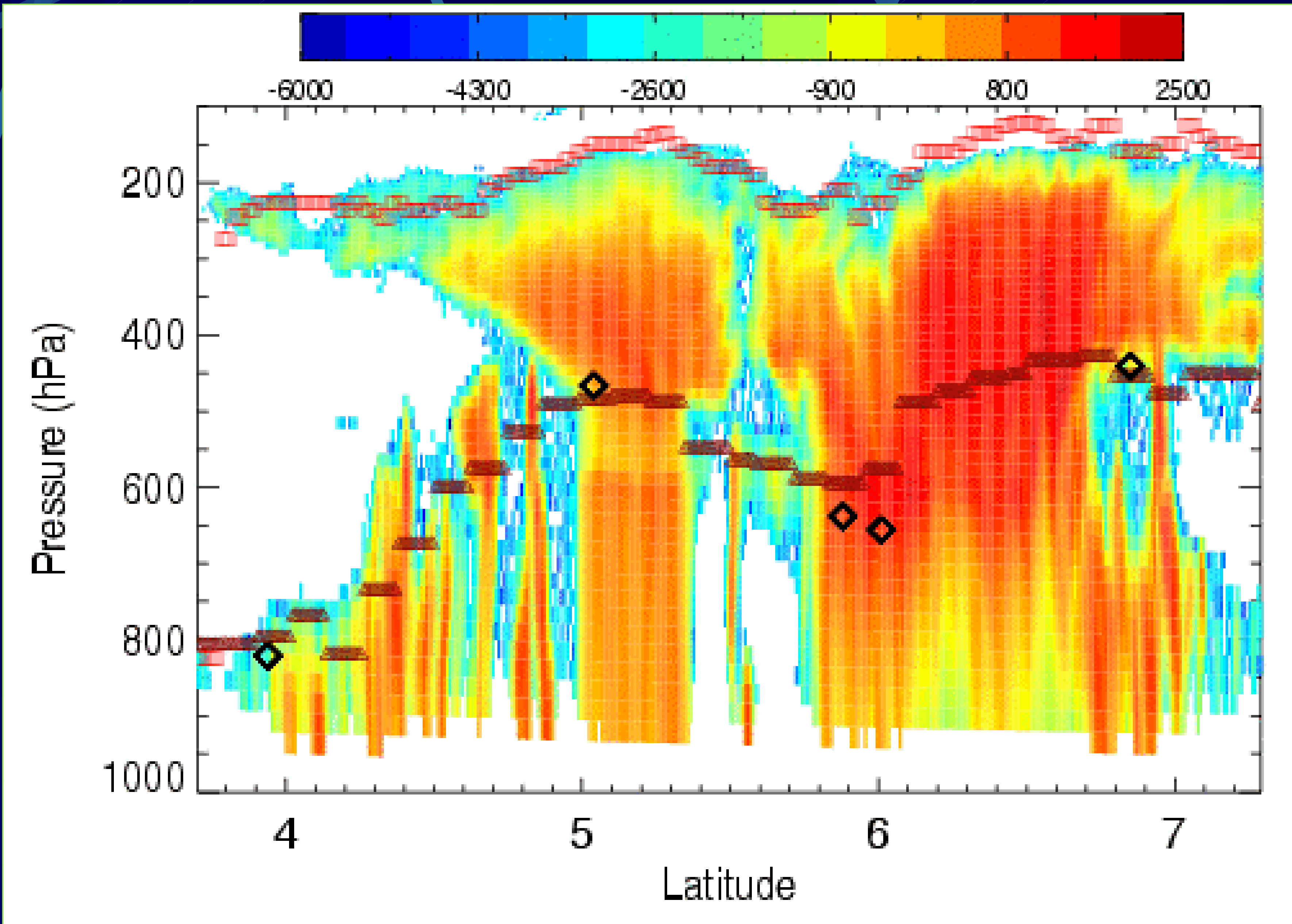
MODIS



sat

DOAS retrievals use cloud pressures from O_2-O_2

TOMS currently uses cloud climatology from therm

can have significant errors over bright clouds); nex

ion (and TOMS reprocessing) will use OMI-derived

atology

estimate radiative cloud fraction from UV/VIS

ctances or radiance ratio, cloud pressures from Ra

tering, O_2-O_2, or O_2 absorption.

iative cloud pressure is distinct from (IR) cloud-top

ificant photon penetration inside clouds

use these concepts e.g. to retrieve in-cloud mixin

s

ain provides unique opportunity to combine cloud

rmation to derive information about cloud vertical e

different passive sensors and validate with active

sors.